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RESEARCH

Sustainable and Innovative Design of Museums' Exhibition Space: A Strategic Approach to Enhance Participation and Satisfaction

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ABSTRACT

PURPOSE: This study examines how design modifications affect museum experiences for 7-18 year olds in Harbin City, Heilongjiang Province, China. Four themes, integration of digital technology, sustainable design practices, flexible and adaptable spaces, and community engagement and inclusivity, are examined to see if they increase museum visitor participation and satisfaction.

METHOD: This research conducted and utilised 30 museum visitors' semi-structured interviews. A three-step coding analysis process identified repeating themes and patterns in the data. Interview standards ensured data collecting consistency and completeness.

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FINDINGS: The findings show that design adjustments significantly affect museum visitor experiences. Digital technology, sustainable design, flexible spaces, and community interaction were key to visitor happiness and participation. Participants enjoyed rich and engaging digital experiences, sustainable design, and adaptable and inclusive museum settings.

ORIGINALITY/IMPLICATIONS: By uncovering how museum visitors interpret spaces, this research advances museum studies, environmental psychology, and community development. The findings can help museum professionals, educators, legislators, and community stakeholders develop more engaging, inclusive, and sustainable cultural spaces that enrich lives.

KEYWORDS: *Integration of Digital Technologies; Sustainable Design Practices; Flexible and Adaptable Spaces; Community Engagement; Inclusivity*

INTRODUCTION

Popular cultural properties that protect and exhibit knowledge of people as well as their history are among the essentials when it comes to museums. Digitalisation has made it possible for museums to be more dynamic places where visitors participate in the knowledge creation process instead of being static sources of objects in display cases (Theofanous *et al.*, 2024). More and more museums use digital technology, sustainable architecture, flexible spaces and community participation to keep up with the changing tastes and expectations of its visitors (Huda, 2024).

Numerous research studies have looked into how design affects museum visitors' experiences (Atutxa *et al.*, 2024). The findings of this research might improve engagement as well as happiness. According to Mrayhi *et al.* (2024), interactive touch screens and augmented reality (AR) improved visitor engagement and information retention. This implies that, depending on personal interests and preferences, there exist several ways to make a visit more memorable. Particular attention was paid to the interactive displays housed in these attractions (Whitford and Brearley, 2024).

Despite many inquiries into this subject, we still do not completely comprehend visitor experience or museum design interventions (Altıntepe *et al.*, 2023). Young travellers between the ages of 7 and 18 have their needs and preferences neglected (Altıntepe *et al.*, 2023). There is less information about this community and its peculiarities in engagement and preferences, even though previous studies focused on design strategies for visitors (Agboola *et al.*, 2023).

The theory of socio-cultural learning (Longo *et al.*, 2022) and experiential learning theory (Karadimitriou *et al.*, 2022) provide theoretical frameworks through which the impact of museum design on visitors can be understood. These ideas give priority to important interactions, participation in society, and the dynamic learning process. The effect of digital technology, flexible space layouts, ecologically responsible architecture, and community involvement on the enjoyment

and engagement of museum goers between the ages of 7 and 18 is examined in this study. Through identification of the most efficient design solutions and procedures, this initiative seeks to improve the area of museum studies and maximise visitor interaction. The aim of this study is to give museum staff direction.

LITERATURE REVIEW

Museum design and construction have seen significant modifications in recent years. Technology developments, changing needs of visitors, and changing architectural styles have all contributed to this change (Ghosh *et al.*, 2022). Rigid layouts and motionless displays have long been features of museums, which discourage audience participation. The audience emphasises immersion, interactivity, and adaptation throughout the design process (Irvine *et al.*, 2022). Using augmented reality/virtual reality (AR/VR) technologies, architects and designers are building immersive settings that enthral guests, and interactive displays, customised tours and virtual exhibitions have the potential to improve museum visits (Sharp *et al.*, 2022); these technologies might also offer some other benefits. This change has made sustainable architecture at museums necessary to follow green building regulations (Rosário *et al.*, 2022).

Integration of Digital Technologies

Integrating digital technologies into the architectural designs of museum spaces can greatly enhance visitor engagement and happiness (Somanath *et al.*, 2021): this is a potentiality that can be actualised. Currently, there is a trend that recognises the impact of technological improvements on our information consumption and interaction approaches (Žlender *et al.*, 2021). When it comes to the preservation of antiquities, locations that were once static have been transformed into interactive ones, suggesting that the integration of augmented reality, virtual reality, and interactive touch screens has the potential to enhance the user experience at museums. As stated by Theofanous *et al.* (2024), this will lead to more immersive experiences compared to those achieved with standard monitors. Compared to other traditional media such as newspapers or television broadcasts, these technologies enhance the relevance of learning content by enabling higher levels of personalisation and immersion (Ur Rehman *et al.*, 2024). This is due to their ability to provide a greater degree of immersion. Virtual reality has the potential to take tourists to reconstructed historical settings and offer them fresh insights into art and culture (Salama and Patil, 2024).

Sustainable Design Practices

Sustainable museum design follows social norms and considers the environment to increase visitor involvement and satisfaction (Mhlongo *et al.*, 2023). With environmental awareness rising,

sustainability-focused institutions can engage audiences. Leadership in Energy and Environmental Design (LEED) accreditation helps museums reduce their carbon footprint, boost energy efficiency, and improve visitor comfort (Agboola *et al.*, 2023). Efficient natural lighting, HVAC systems, and eco-friendly materials create comfortable and attractive visitor rooms, and natural light makes display rooms more appealing to visitors (Bianchi and Schmidt, 2023). Historical buildings are preserved while new, eco-friendly technologies are integrated through adaptive re-use. This creates a unique and unforgettable tourist experience that blends past and present (Longo *et al.*, 2022).

Flexible and Adaptable Spaces

Flexible rooms within museum architecture are designed to make visitors engaged with different preferences and satisfaction levels, increasing their desire or interest (Carroll and Mallon, 2021). They acknowledge that exhibitions within museums will change over time as well as their programming; this also has implications for audience expectations (Iniesto *et al.*, 2021). By having flexible spaces built into them, museums ensure that they remain relevant at all times because they can accommodate a wide range of exhibitions, activities or experiences involving different types of visitors (Somanath *et al.*, 2021).

Community Engagement and Inclusivity

Community involvement and inclusivity boost museum attendance and satisfaction. Establishing real ties, seeing museums as community cultural institutions, and ensuring varied demographic representation are essential (Najafi *et al.*, 2023). Museums may involve local communities by authentically portraying visitors' identities and interests, and outreach, collaborative programming, and participatory displays can help this (Mhlongo *et al.*, 2023). This kind of communication fosters understanding, cultural interchange, and affiliation. Displays selected by the community provide visitors with many perspectives and this may promote learning and discussion (Altıntepe *et al.*, 2023).

METHODOLOGY

The research's target audience was Chinese museum tourists from Heilongjiang Province's Harbin City, ages 7 to 18 (Table 1). The study carefully selected a sample of 30 people who came within the relevant age range to ensure a diverse and inclusive representation. Participants on the museum tours were interviewed in semi-structured interviews; interview guidelines were written before the interviews to guarantee consistency and thoroughness in the data collecting (Table 2). The guidelines highlighted the use of digital technologies, sustainable design, flexible and movable spaces, and community involvement and inclusion. To prevent interruptions and preserve privacy, the museum offered a quiet and cosy setting for the interviews.

Table 1: Respondents' Profile

Age Group	*Number of Participants*	*Gender Distribution*	*Educational Level*	*Location*
07-10	10	7 Male, 3 Female	Primary School	Harbin City, Heilongjiang Province, China
11-14	10	5 Male, 5 Female	Middle School	Harbin City, Heilongjiang Province, China
15-18	10	4 Male, 6 Female	High School	Harbin City, Heilongjiang Province, China

Source: Constructed by authors

Table 2: Interview Guidelines

Theme	*Interview Guidelines*
Integration of Digital Technologies	1. How do you feel about the digital experiences available in the museum?
	2. Can you describe a memorable interaction with a digital exhibit or technology?
	3. Do you think digital technologies make your museum visit more enjoyable or educational?
	4. What suggestions do you have for improving or expanding digital experiences in the museum?
	5. How do you think digital technologies could better engage visitors your age?
Sustainable Design Practices	1. Have you noticed any environmentally friendly features in the museum?
	2. How do you feel about the design and layout of the museum space?
	3. Do you think sustainable practices are important for museums?
	4. Can you suggest any additional ways the museum could be more environmentally friendly?
	5. How do sustainable practices affect your overall experience as a visitor?
Flexible and Adaptable Spaces	1. Do you feel comfortable moving around and exploring different areas of the museum?
	2. Have you ever participated in any interactive or hands-on activities at the museum?
	3. What do you think about the flexibility of the museum's layout and exhibits?
	4. Can you recall a time when the museum space changed for a special event or exhibit?
	5. How do you think the museum could better accommodate visitors your age?
Community Engagement and Inclusivity	1. Do you feel like the museum represents people like you?
	2. Have you attended any events or programmes at the museum targeted towards young people?
	3. How do you think the museum could involve young visitors more in its activities and exhibits?
	4. Have you seen exhibits or programmes in the museum that celebrate diversity and inclusion?
	5. What suggestions do you have for making the museum more welcoming and inclusive for visitors your age?

Source: Constructed by authors

This study evaluated the museum experiences of 7-18 year olds in Harbin City, Heilongjiang Province, China, using a systematic approach. The research revealed museum visitors' pleasure and participation by using semi-structured interviews, data analysis, and rigorous validation. These findings have major implications for museum studies and for museum workers, educators, policy-makers, and community stakeholders. They want better visitor experiences, cultural participation, and sustainability.

RESULTS

This research elucidates the intricate correlation between design interventions and museum visitor experiences, uncovering the factors influencing the engagement and contentment of 7-18 year old visitors in Harbin City, Heilongjiang Province, China. The study reveals the multifaceted consequences of four primary themes: digital technology integration, sustainable design, flexible and adaptable spaces, and community participation and inclusivity.

Integration of Digital Technologies

This study examined how digital technology affects visitor experiences in 7-18 year olds. In general, digital technologies increase the engagement and satisfaction of young museum visitors. The relevance of immersive experiences and interactive digital exhibitions in enhancing museum visits was emphasised by the participants. Digital technologies were seen to improve museum relationships since they allowed for individualised exploration and interactive learning (Table 3).

Table 3: Thematic Analysis of Integration of Digital Technologies

Theme	*Frequency*
Augmented Reality	15
Virtual Reality	12
Interactive Touchscreens	18
Digital Exhibits	20
Personalised Tours	10
Data Analytics	8
Overall Satisfaction with Technology	25

Source: Constructed by authors

> *Interviewee 7 (Age 9, Female):* "I thoroughly enjoyed the virtual reality exhibit that allowed me to explore the historical landscape of ancient China. I had the impression that I was actually there because the experience was so immersive".

Digital technologies improve visitor engagement, as shown in this quote. The interviewee felt immersed in the museum's content thanks to virtual reality. Such encounters entertain and educate, letting visitors experience historical or cultural surroundings.

> *Interviewee 15 (Age 14, Male):* "The interactive touchscreens were highly impressive as they allowed me to acquire additional knowledge about the exhibits in an enjoyable manner".

Interactive digital exhibits teach, as this quote shows (Figure 1). Touchscreens can help museums accommodate different learning methods and interests, making the visit more enjoyable for young people.

Digital technologies improve museum visitor engagement, as shown by previous research. According to Bricout *et al.* (2021), interactive digital exhibits enhanced visitor attention and information retention more than static displays. Similarly, McKinley *et al.* (2021) found that virtual reality in museums increased visitor happiness and learning outcomes. Digital technology should be integrated into museum spaces to improve visitor experiences and encourage active participation with cultural heritage and educational material.

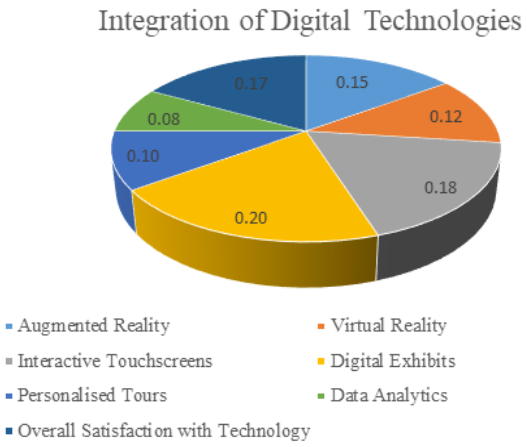

Figure 1: Weightage analysis of Integration of Digital Technologies

Source: Constructed by authors

Sustainable Design Practices

Sustainable design techniques for 7-18 year olds in museums at Harbin City, Heilongjiang Province, China, showed that eco-friendly aspects improve visitor experiences. The museum visitors said sustainable design made their visits more enjoyable. Energy-efficient technologies, eco-friendly materials, and natural lighting have all been used to create beautiful and enjoyable spaces. The significance of sustainability in preserving natural resources and reducing the ecological impact of the museum was comprehended by the attendees (Table 4). This shows how devoted and aware of the environment younger tourists are.

Table 4: Thematic Analysis of Sustainable Design Practices

Theme	*Frequency*
Natural Lighting	16
Energy-efficient Systems	14
Eco-friendly Materials	18
Recycling Programmes	12
Waste Reduction	10
Indoor Air Quality	9
Visitor Satisfaction with Sustainability	22

Source: Constructed by authors

> "The museum was airy and light, especially when there was natural light", said *interviewee 4, a male, eleven years old:* "I felt more a part of the natural world".

This declaration highlights the enhancement of visitor comfort and atmosphere via sustainable design. Natural lighting improves sight and adds to a more pleasurable atmosphere in a museum. The response implies that including natural elements into museum architecture may improve visitors' capacity to form deeper bonds with the natural world.

> *Interviewee 22, a female 16-year-old,* thanked the museum for using reclaimed materials and for trying to reduce the generation of rubbish. She said: "Knowing that I was leaving relieved me".

This comment shows how designing ecologically friendly structures may make visitors feel responsible and satisfied. Recycling and reduction of waste are two good ways for museums to demonstrate their dedication to environmental protection and to entice guests to think about sustainability. Encouraging the discussion of important ideas can improve visitor happiness and strengthen interpersonal relationships. The findings of this study confirm those of past research that demonstrate how sustainable design improves museum visitors' experiences (Figure 2). According to research by Jost *et al.* (2021), museums with green design components were more responsible to the environment and had happier visitors. Incorporating energy-efficient ventilation and lighting improved the building's air quality and degree of comfort, claim Žlender *et al.* (2021). This enhancement led to higher degrees of enjoyment and involvement from the guests. These results underline the value of environmentally friendly museum design in improving visitor experiences.

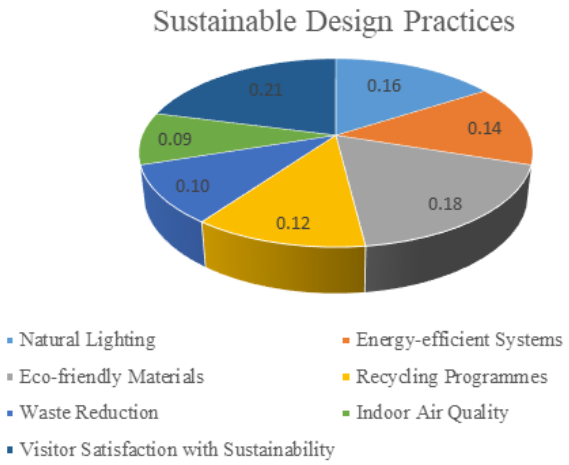

Figure 2: Weightage analysis of Sustainable Design Practices

Source: Constructed by authors

Flexible and Adaptable Spaces

This research shows that young people aged 7 to 18 are more interested and satisfied visitors to museums in Harbin City, Heilongjiang Province, China. Participants claimed that the museum's flexible spaces encouraged interaction and inquiry. Travelling displays and flexible design allowed visitors to tailor their museum visit to their own interests and learning preferences. Customising museum experiences through flexible rooms promoted a feeling of ownership and belonging (Table 5). The outcomes show how flexible museum environments are essential to enhance visitors' experiences.

Table 5: Thematic Analysis of Flexible and Adaptable Spaces

Theme	*Frequency*
Movable Exhibits	17
Modular Layouts	13
Interactive Activities	20
Special Events	15
Customisable Experiences	11
Participant Ownership	14
Visitor Satisfaction with Flexibility	23

Source: Constructed by authors

> "It was convenient to be able to move the seats around and take a seat anyplace", said *Interviewee 9 (a female, age 8).* "I thought the museum was designed especially for me."

This remark shows how young museum goers need to adapt. If guests change the chairs or choose their own viewing spots, they could feel more in control and autonomous in museums.

> *At thirteen years old, a male interviewee said,* "I particularly enjoy the robot-building exhibit. I cherished the way the museum transformed for holidays".

Communications and involvement are promoted by flexible venues. Interactive museum experiences can be improved by special events and temporary displays. This study validates earlier studies that demonstrate that flexible and adaptable museum settings boost visitor satisfaction and participation. Flexible and interactive museums have raised learning and enjoyment for visitors, claim Theofanous *et al.* (2024). Huda (2024) found that the more pleasurable museums were those that could hold a range of displays and events. These findings emphasise the need of museums to adjust to the shifting demands and interests of their visitors in order to promote cross-cultural and educational interaction (Figure 3).

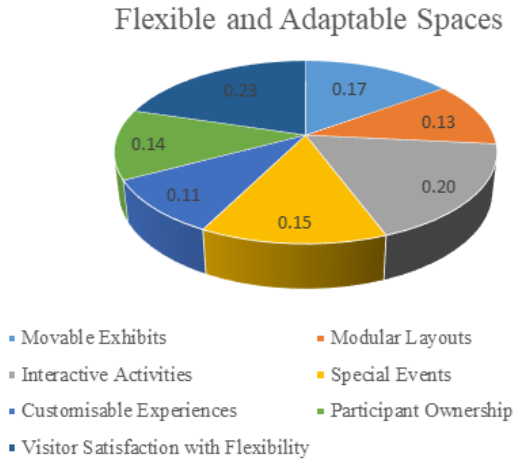

Figure 3: Weightage Analysis of Flexible and Adaptable Spaces

Source: Constructed by authors

Community Engagement and Inclusivity

Museums for children age 7-18 in Harbin City, Heilongjiang Province, China encouraged diversity and community service; this helped guests feel more at home. The participants felt that museums ought to stress diversity and inclusivity. The capacity of cultural festivals, co-operative exhibitions, and outreach to improve understanding between cultures was valued. Accessibility was also stressed in order to make museums welcoming to individuals of all ages, abilities, and origins (Table 6). The results indicate that museums must promote variety and community interaction to be engaging and friendly to people of all ages.

Table 6: Thematic Analysis of Community Engagement and Inclusivity

Theme	*Frequency*
Outreach Programmes	19
Collaborative Exhibits	16
Cultural Celebrations	14
Accessibility Features	18
Diversity Representation	15
Inclusive Programming	12
Visitor Satisfaction with Inclusivity	21

Source: Constructed by authors

Interviewee 3 (ten years old, female): "I thoroughly liked the cultural event at the museum, where we tried different meals and discovered about other traditions. It was like travelling the world without ever leaving the city".

This quote captures the impact of community service on visitors. By holding events and festivals that highlight diverse cultures and cuisines, museums may help to foster understanding between people.

Aged 17, male respondent number 26 said, "I like the museum's ramps and braille lettering. It indicates they want to embrace everyone".

This quote shows how accessibility to museums encourages diversity. Because of ramps and braille labels, museums are more fair and accessible to visitors with impairments. This study supports earlier studies that demonstrate that visitors to museums are more satisfied and culturally relevant when there is community involvement and inclusion, as shown in Figure 4. Outreach and joint exhibitions increased visitor experience and cultural value, claim Salama and Patil (2024). Enwin and Ikiriko (2024) state that accessible and inclusive museums promoted diversity and unity of the community. Museums need diversity and real connections to empower people of all ages and origins.

Figure 4: Weightage Analysis of Community Engagement and Inclusivity

Source: Constructed by authors

DISCUSSION

The museum design uses sophisticated features to engage and educate all ages. This is where history and technology meet, and where habits and trends are intertwined. Digital technology, environmental practices, adaptive layouts, and community involvement have transformed museums into immersive and inclusive spaces. In this dynamic setting, this study explores the happiness and desire to participate in museum activities among 7-18 year olds in Harbin City, Heilongjiang Province, China. This research explores design interventions and their impact on museum visitors' exploration and enjoyment. Four subjects that represent key aspects of current museum architecture will be examined to achieve this.

Digital technology in museums significantly affected 7-18 year old visitors' experiences, according to studies. Augmented reality (AR), virtual reality (VR), and interactive touchscreens engage and entertain young museum visitors. Participants praised their immersive and captivating museum experiences, proving that technologies improve instructional value. Augmented and virtual reality immerse visitors in historical and cultural contexts for museum material. Touchscreens made presentations more engaging and interactive, and customised learning and research. Digital technologies boost museum visitor engagement and learning (Atutxa *et al.*, 2024).

Museums were recognised for their adaptability to diverse learning methods. Transportable displays and modular architecture made gallery spaces easy to change exhibits and themes, and gave visitors unique and interesting experiences. Interactive activities and hands-on exhibits helped

visitors learn by exploring. Whitford and Brearley (2024) emphasise adapting museums to people' evolving needs and interests; this produces inclusive, dynamic ecosystems. Museum visitors also value community involvement and inclusivity. The findings show that outreach, shared displays, and cultural events connect museum visitors. Attendees praised museums' community engagement and diverse opinions, saying that museums teach about different cultures. Outreach and collaboration displays allowed community participants to determine museum material, building ownership and commitment. Cultural festivals and inclusive museum programming help visitors appreciate varied identities and practices, making museums welcoming (Baranauskas *et al.*, 2024).

Diversity, community involvement, and adaptable spaces need dynamic, welcoming, and interactive museum settings. Museum attendance, enjoyment, and cultural significance for all ages may rise with flexible, community-driven museums. These results further motivate museum staff to support diversity and community involvement in development and planning. A museum can promote conversation and social contact (Agboola and Tunay, 2023).

CONCLUSIONS

This study demonstrates how intricately design and museum visitor experiences are related. Additionally, it discloses what makes visitors aged 7-18 joyful and involved. According to the study, innovation, sustainability, adaptability, and variety are essential for memorable and transforming museum experiences. This was achieved by evaluating four key themes: digital technology integration, sustainable design methods, versatile and adaptable spaces, and community involvement and inclusivity. The study's limitations must be acknowledged and future research must address them and explore new areas. The study has advanced museum studies, environmental psychology, and community development, yet it has limitations. Museum workers, educators, policy-makers, and community stakeholders must collaborate to improve cultural environments. The theoretical and practical results of this research should be used to help enrich individuals and communities by creating engaging, inclusive, and sustainable cultural contexts: we appreciate our cultural history more through our collaboration. Our research concludes that design interventions shape museum experiences. It also stresses the importance of constant innovation, collaboration, and adaptation to meet museum visitors' changing needs in a changing environment.

Implications of the Study

This research affects education, environmental sustainability, community participation, and cultural preservation beyond museum design. The study reveals the complex relationships between museum design and visitor experiences, advancing experiential learning and environmental psychology. According to Kolb's experiential learning theory (1984) and Vygotsky's socio-cultural theory (1978), active involvement, individualised investigation, and interpersonal communication enhance

meaningful learning experiences. This study shows that sustainable design methods improve visitor happiness and environmental responsibility, advancing sustainable development and eco-conscious design discourse. Museums are inclusive institutions that promote variety, conversation, and mutual understanding among varied communities, which affects community development and social cohesion. This study helps us understand museums' different functions in society and shows how design changes can provide significant and uplifting experiences outside of museums.

This research can benefit museum staff, educators, legislators, and community stakeholders who want to improve visitor experiences, promote environmental sustainability, encourage community participation, and preserve cultural heritage. It analyses successful design ideas and their effects on visitor satisfaction and engagement to help museums create more appealing and inclusive environments. The findings can help museum professionals customise exhibit design, programming, and visitor engagement to varied populations. Sustainable design integrates eco-friendly construction materials, energy systems, waste management, and restoration into museum operations. This research may help educators and policy-makers promote lifelong learning and civic engagement. Experiential learning and community interaction are integrated into school curricula and cultural practices. Community stakeholders can utilise the statistics to advocate for more museum accessibility, inclusivity, and variety to ensure that cultural institutions remain thriving centres of innovation, education, and social interaction for future generations. The research provides a detailed approach for developing sustainable, inclusive, and rewarding environments outside museums for individuals, communities, and society.

Limitations and Future Research Directions

This study produced significant information, but its limitations must be understood. These include the research's specific focus on Harbin City, Heilongjiang Province, China, and that the study included only 7-18 year olds. Different cultures may find it inappropriate. This study used self-reported data that may be biased by social desirability and recollection. The cross-sectional approach makes causal linkages and long-term impacts of design interventions on visitor behaviour and attitudes difficult to establish. The study assessed various design aspects; however, it may not have covered all museum visitor encounters. The findings may become outdated due to design and technology developments, underlining the necessity for continual research and modification.

Given these findings, further research could examine several museum architecture and visitor experience improvements. Initially, longitudinal research could explore how design interventions affect visitor behaviour, attitudes, and learning. Comparative studies of different age groups, cultures, and museums can show how design principles apply to visitor experiences and how contextual factors affect them. Mixed methods research that incorporates qualitative and quantitative data can help us understand the complex interaction between museum design, visitor perceptions, and

socio-cultural dynamics. Technology, inclusive design, and environmentally responsible museum operations can be researched to gain new insights and best practices. Museums, academic institutions, and community organisations can collaborate to improve museum programming and design by co-creating and sharing information. To improve museum studies and create comprehensive, inclusive, and durable cultural experiences for all, scholars and specialists must overcome these limits and embrace these prospective study topics.

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